PATENT SPECIFICATION 930,062

NO DRAWINGS.

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930,062

Date of filing Complete Specification : Oct. 7, 1959.

Application Date : July 7, 1958. No. 21775/58.

Complete Specification Published : July 3, 1963.

Index at Acceptance :—**Classes 140,** A2(F:G:N1:N3), A7, A10(A:B1:B3), A16(A:B1:B3) ; **37,** M1(B2B2:G4:G6:J2), R2A(1E:1V:3T:4M), R2J3 ; **and 140,** E1H.

International Classification :—**B29d** (B05, H01n, H02g).

COMPLETE SPECIFICATION.

Improvements relating to Films and Sheets, having a Thin Metal Coating.

We, MAY & BAKER LIMITED, a British Company, of Dagenham, Essex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to metallised films and sheets.

It is known to deposit a thin metal coating on films and other articles by deposition from the vapour phase in a high vacuum, and such coatings may for convenience be termed "vacuum-deposited". Unfortunately many materials are not satisfactory for use as base materials in such processes, either because they undergo changes as a result of the high vacuum and/or high temperature to which they are exposed in the process or because they require so long an out-gassing time that the application of the vacuum-deposition method is rendered impracticable. Examples of such materials are compositions containing thermosetting resins and the very valuable plasticised polyvinyl chloride.

The present invention provides a method which, among other advantages, makes it possible to produce very thin metal coatings on films, foils and sheets comprising a material which it is not feasible or practicable to coat by the vacuum-deposition method, through it is not limited to the treatment of such articles.

According to the invention there is provided a process for the preparation of self-supporting films and sheets carrying a thin metal coating which comprises forming a self-supporting sheet or film (a) in direct contact with the metal surface of a sheet or film (b) carrying a vacuum-deposited metal coating, the said contacting operation being carried out under conditions adapted to cause a substantial degree of cohesion between the metal surface and the sheet or film (a), and subsequently separating sheet or film (a) and (b), whereby the metal coating is left on the surface of the sheet or film (a).

For the sake of brevity the film or sheet to which the metal coating is to be transferred will hereinafter be referred to as the "product", and the film or sheet which initially carries the metal coating will be referred to as the "base", the term "coated base" being used to denote the combination of base and metal coating.

The product may be formed on the vacuum-deposited metal coating of a coated base by any known method of forming such products. For example a solution of the material from which a product is to be made (the "product material") may be spread, cast or extruded onto the metal coating and set either by evaporation of the solvent or by means of a liquid coagulant in the known way. When the resulting film or sheet is separated from the base, the metal coating will be found adhering to it in the form of a mirror of brilliance corresponding to the smoothness of the surface of the base.

In such a process, it is usually advisable to use as the base material a material which is not substantially affected by the solvent used in making the solution of the product. An example of a class of base materials which are useful under a wide range of conditions is provided by the linear condensation polymers, such as polyamides and in particular polyesters, especially polyethylene terephthalate ; another is the polyvinyl acetals, for example polyvinyl formal. Cross-linked polyester and

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other resinous materials are also suitable. Cellulose acetate and other cellulose esters on the other hand are more sensitive towards solvents, and their use, while otherwise satisfactory, may give rise to some wrinkling in the transferred metal coating. The base may be relatively thick, or it may be about as thin as is compatible with its separation without tearing from the laminate.

A wide range of product materials may likewise be employed. Examples of such materials, many of which are inherently unsuitable for direct coating by vacuum-deposition, are polyvinyl chloride, copolymers of vinyl chloride with vinyl acetate and vinylidene chloride respectively, polyvinyl alcohol, simple and mixed cellulose esters such as cellulose acetates and cellulose acetate butyrates, cellulose ethers of the organic solvent-soluble type such as ethyl cellulose, and water-soluble cellulose ethers such as methyl and hydroxyethyl cellulose.

Solutions of these materials in appropriate solvents may be formed into films on the metal coating on the base in any known way and may then be set. Usually it is convenient to use a volatile solvent and to set the film by evaporation of the solvent. In many cases the presence of a certain amount of residual solvent in the product when it is separated from the base is not disadvantageous, but in others, especially when the base material is liable to be affected by the solvent, it is preferable to remove it substantially completely.

Other product materials which may be used in accordance with the invention may consist of any material to which the metal can be caused to adhere, e.g. by means of heat and pressure; for example the product may be formed from a cross-linkable resin, such for example as a cross-linkable polyester resin, phenol-formaldehyde resin or urea-formaldehyde resin. If desired, the product material may comprise a resin/fibre composition suitable for the production of hardboard. Before the stripping step the resin may be subjected to heat and pressure or other conditions which will cause cross-linking to occur. The base may then be stripped from the formed product thus leaving the metal coating firmly adherent to the product.

The process of the invention has many useful applications. For instance, as already stated, it can be used to provide very thin and highly specular metal coatings on films and sheets which cannot themselves conveniently be subjected to vacuum-depositing conditions, either because they are not stable under these conditions or because, for one reason or another, they require an exceptionally long out-gassing treatment. The metal coating on the product may be purely decorative or may for instance be employed for its heat-reflecting or other physical properties.

Another valuable application of the invention is in the production of "printed circuits". One known method of producing these consists in making a continuous film of silver on a suitable base, e.g. a phenolic resin base, by applying an adhesive to the base and then, over the adhesive, a layer of chemically reduced silver. This layer is then covered with a resist except where the circuit elements are to be, and these are then formed by the electro-deposition of copper on the uncoated areas. When these have built up to a sufficient depth of conducting material, the resist is removed as is also the layer of silver underneath it.

In accordance with the present invention, this process is simplified by applying a metal coating to the product material, by the method described above. Such a coating being substantially continuous provides an admirable conducting medium for the current used in the electro-deposition of the further copper or other metal. When the circuit elements have been sufficiently built up, the resist is removed by any known means, after which the thin metal coating between the built up circuit elements is readily removable, as for example by buffing. In such a process the thin metal coating first applied to the base as well as the conducting metal deposited on the circuit elements is preferably copper.

Another electrical application of the invention is in the production of capacitors. A well known type of capacitor comprises a stack of metallised films, the metal forming the conducting "plates" and the film the dielectric. In such constructions, it is necessary to remove the metal from a strip along the edge of each section of film. This may be done very advantageously in accordance with the invention by applying a coating of a film-forming material, e.g. a vinyl copolymer as already described, and then, when the solvent has been evaporated or been removed in some other way, stripping off the resulting film together with the metal with which it was in contact. The method can of course be used in other processes in which it is desired to remove a vacuum-deposited metal coating over particular predetermined areas, for decorative or any other purposes.

The process of the invention can be carried out using any metal of which coatings can be formed by the vacuum-deposition technique; copper and aluminium are particularly useful examples, though other metals, for instance silver and zinc, can also be used.

The invention is illustrated by the following Examples:—

EXAMPLE I.

A thin layer of aluminium was vacuum-deposited on a film of polyethylene terephthalate 0.005 inch thick. A film of a

vinyl chloride/vinyl acetate/maleic acid copolymer ("Vinylite VMCH") containing 10% of triphenyl phosphate as plasticizer was cast onto the metallised surface from solution in a mixture of equal weights of methylene chloride and trichloroethylene. After the solvent had evaporated, the vinyl copolymer film was stripped from the polyethylene terephthalate base. The stripped film had a bright uniform coating of aluminium, and the polyethylene terephthalate film remained free from metal and could be remetallised and used again. (The word "Vinylite" is a registered Trade Mark.)

EXAMPLE II.

The same procedure was carried out, with the same result, using copper in place of aluminium.

EXAMPLE III.

The same procedure as in Example I was carried out, with the same result, using in place of the vinyl copolymer solution, an aqueous solution of polyvinyl alcohol ("Polyviol W 25/14"), or a blend of polyvinyl alcohols ("Polyviols W 25/14 and W 100/450"). Again the aluminium coating was transferred to the polyvinyl alcohol film. The same result could be obtained using copper in place of aluminium.

EXAMPLE IV.

The procedure of Example I was followed, using as the base a sheet of cellulose acetate 0.008 inch thick and as the film casting solution a solution of ethyl cellulose ("Dow Ethocel, Standard Ethoxy Content, Viscosity Grade 100") in the same solvent. The metal coating was completely transferred to the ethyl cellulose film, but apparently as a result of the action of the solvent on the cellulose acetate base; it had a somewhat wrinkled appearance. (The word "Ethocel" is a registered Trade Mark.)

EXAMPLE V.

A sheet of polyethylene terephthalate 0.005 inch thick was coated with copper by the vacuum-deposition method. Along each edge and down the centre of the sheet was deposited a strip of vinyl chloride/vinyl acetate/maleic acid film as described in Example I. The dried film was then stripped off with the metal.

WHAT WE CLAIM IS:—

1. Process for the preparation of self-supporting films and sheets carrying a thin metal coating which comprises forming a self-supporting sheet or film (a) in direct contact with the metal surface of a sheet or film (b) carrying a vacuum-deposited metal coating, the said contacting operation being carried out under conditions adapted to cause a substantial degree of cohesion between the metal surface and the sheet or film (a), and subsequently separating sheet or film (a) and (b), whereby the metal coating is left on the surface of the sheet or film (a).
2. Process according to Claim 1 in which the sheet or film (a) is formed by casting or extrusion.
3. Process according to Claim 1 or 2 in which the sheet or film (a) is made of a vinyl chloride, vinylidene chloride, vinyl alcohol or vinyl acetate polymer.
4. Process according to Claim 1 or 2 in which the sheet or film (a) is made of a cellulose ether or ester.
5. Process according to Claim 1 or 2 in which the sheet or film (a) formed in contact with the metal surface comprises a cross-linkable thermosetting resin, which is cured after the said contact has been effected.
6. Process according to Claim 1 substantially as described in the Examples.
7. Process according to Claim 1 substantially as described.
8. Self-supporting films and sheets provided with a thin metal coating when made by the process claimed in any of the preceding claims.

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Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1963.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.